AEROSOL PROCESS FOR FABRICATING DISCONTINUOUS FLOATING GATE MICROELECTRONIC DEVICES

ABSTRACT OF THE DISCLOSURE

A process for forming an aerosol of semiconductor nanoparticles includes pyrolyzing a semiconductor material-containing gas then quenching the gas being pyrolyzed to control particle size and prevent uncontrolled coagulation. The aerosol is heated to densify the particles and form crystalline nanoparticles. In an exemplary embodiment, the crystalline particles are advantageously classified by size using a differential mobility analyzer and particles having diameters outside of a pre-selected range of sizes, are removed from the aerosol. In an exemplary embodiment, the crystalline, classified and densified nanoparticles are oxidized to form a continuous oxide shell over the semiconductor core of the particles. The cores include a density which approaches the bulk density of the pure material of which the cores are composed and the majority of the particle cores are single crystalline. The oxidized particles are deposited on a substrate using thermophoretic, electrophoretic, or other deposition means. The deposited particles form a stratum or discontinuous monolayer of oxidized semiconductor particles. In an exemplary embodiment, the stratum is characterized by a uniform particle density on the order of 10^{12} to 10^{13} particles/cm^2 and a tightly controlled range of particle sizes. A plurality of adjacent particles contact each other, but the oxide shells provide electrical isolation between the particles of the stratum. Clean processing techniques provide a density of foreign atom contamination of less than 10^{11} atoms/cm^2. The stratum is advantageously used as the floating gate in a non-volatile memory device such as a MOSFET. The non-volatile memory device exhibits excellent endurance behavior and long-term non-volatility.